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ABSTRACT

This booklet gives two- or three-page biographies of seventeen women scientists. They range in history from Agnodice (physician, 300 B.B.) to Jane Goodall (born 1934). In addition, brief sketches are given of twenty-three other women scientists. This anthology is intended to fill a need for curriculum materials and literature that provide positive role models of women as scientists. (BB)

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BIOGRAPHIES OF WOMEN SCIENTISTS -PAST and PRESENT-

Our history has been
stolen from us.
Our heroes died in
childbirth, from
peritonitis
overwork
oppression
from bottled up rage.
Our geniuses were
never taught to
read or write.
We must find our
past adequate
to our ambitions.
We must create a
future adequate
to our needs.

---adapted from The Old Mole newspaper Cambridge, Mass., 1969

Developed by the "Women & Science" class, University of Washington Women Studies Program, Summer 1975

Coordinated by Susan Schacher

Published and distributed by Feminists Northwest, Seattle, Washington

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HYPATIA'S SISTERS

BIOGRAPHIES OF WOMEN SCIENTISTS -PAST and PRESENT-

INTRODUCTION

This booklet originated in a course, "Women & Science," offered in the Women Studies program at the University of Washington during the summer of 1975. People participating in the course were of diverse backgrounds and perspectives, varied educational and work experiences. We were teachers, healthcare workers, undergraduate and graduate students in the sciences and social sciences, and members of the nonacademic community. None of us were professional historians.

We decided to put together this anthology of biographies because we think it is important for people to realize that women have been active as natural scientists since the beginning of human society. We didn't intend this anthology to be a scholarly work, but rather an effort to fill a need for curriculum materials and literature that provide young people with positive role models of women as scientists.

After reviewing the lives of many women scientists of the past and present, we chose to write biographical sketches about women who we thought were particularly important, interesting, or inspiring. Although our anthology tells of women from many historical eras, it is by no means comprehensive. We hope that our efforts will encourage people to seek additonal information about the accomplishments of women in science, as well as in other areas of human endeavor.

The women included in this booklet pioneered the entrance of women into science. Some were revolutionary figures; others made places for themselves without challenging the existing social order. Some of the women came from poor families and struggled for education and work opportunities, but most were from well-to-do families that had the money and leisure to provide formal education for their children. Most of the biographies are about white women from Europe and the United States; women of color and women from other parts of the world have had even less access to education and have had fewer opportunities to do work in science.

The women we tell about fought to participate in fields which for a long time have been dominated by white upper and middle class men. In doing this, each woman in her own way helped to challenge the myth that women are biologically, emotionally, and intellectually unsuited to study natural science, medicine, and technology. Since the history of women has been misrepresented and even ignored, the stories of the women presented in this booklet are needed to challenge another myth by showing that women have been, since ancient times, productive and creative scientists.

In the biographies we wrote, we decided to refer to the women by their first names. There are two reasons for this. The first name is more personal than the surname, and we wanted the biographies to express the sense of camaraderie we felt with these women. In addition, since it

has been customary for a married woman to give up her father's surname and take her husband's, we felt that a woman's first name is more her own than any other.

Articles for this booklet were written by: Debbie Israel, Debbie Oppenheimer, Elly Lindborg, Ingrid Ongaro, Jennifer Wear, Kathy Skinner, Keelin Curran, Lisa Marahrens, Pam Plumb, Sue Ries, and Susan Schacher. Kathy, Lisa, and Pam did the preliminary editing; and Susan coordinated the publication.

We'd like to thank the following people who read the rough draft for their helpful comments and suggestions: Antoinette Wills, Audra Adelburger, Caryl Roman, David Springer, Deirdre O'Neill, Judy Lamare, Phil Bereano, Sally Mackle, Sharon Kaylen, and Sue-Ellen Jacobs.

We'd also like to thank Leslie Snodgrass for her illustrations; Michael Fratini for layout and paste-up; Linda Roman for typing; Steve Itano for photography; and Workin' On It Lesbian Press for printing.

Finally, we'd like to thank Feminists Northwest for publishing and distributing this booklet. Feminists Northwest is a non-profit education group working to end sex discrimination in schools and society.

We hope you will find this booklet interesting and helpful, and that you will share with us your reactions and criticism.

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BEFORE WRITTEN HISTORY: EARLIEST WOMEN SCIENTISTS

In modern society, men have been given credit for most productive, intellectual, and creative achievements. This is probably responsible for the belief that most early knowledge was also developed by men. But some researchers have concluded that women made important contributions to early science and technology.

Early societies (and many of today's hunting and gathering societies) have traditionally been described in terms of a strict division of labor between the sexes: men hunted for the "main course" while women gathered the "trimmings." Recently, however, some anthropologists and archaeologists have challenged this idea, saying that women participated in hunting and men took part in gathering, and that the main sustenance of the diet was provided not by hunting but by gathering and digging.

Through their work on food production, women gained much information about plants -- knowledge which ultimately gave rise to the agrisciences as we now know them. Early women became acquainted with various plants and made use of their individual characteristics. They cultivated and selected wild edible plants for their desirable traits, such as yield capacity and drought resistance. The agricultural work of early women led to the cultivated food crops we eat---including wheats, barleys, millets, maize, manioc (an edible starchy root), squashes, and other plants.

In addition to cultivating plants, early women developed methods of cooking and preserving foods; figured out how to domesticate animals; and produced cooking and storage vessels from wood, bark, clay, and animal skins. They devised ways to weave cloth and baskets; tan and prepare hides; build storage structures and houses. Women applied their botanical knowledge to become heal-

"THE MOST ANCIENT KNOWN PICTORIAL RECORD OF A WOMEN DOCTOR" deleted from this page due to copyright restrictions.

ers skilled in the medicinal use of herbs. Women also took part in developing the concept of number and other early mathematical ideas.

Fire could have been discovered by either men or women, but the knowledge of how fire could be used to transform the nature of various substances was essential to the work women did. Women made clay pots, using fire to harden soft clay. They subjected manioc, poisonous in its natural state, to sieving and heating to prepare casava, an edible bread. Women made water-tight, fire-resistant wooden cooking vessels from hollowed out pieces of wood, using a process of controlled burning with fire and wet strips of bark.

Through these and other labors, women, as early scientists and inventors, developed the tools and techniques that were the foundation of our material culture.

"...A Kurnai aborigine in Australia ...said that man's work was to hunt, spear fish, fight, and then 'sit down.' Women's work was to do 'all else.'"

---Evelyn Reed, Woman's Evolution, 1974

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AGNODICE

physician

around 300 B.C.; Athens, Greece

Agnodice (Ag nod' i see) was a Greek physician who brought about the legalization of medical practice for freeborn women of the Athenian city-state.

In the third century B.C., when Agnodice lived, Athens had an economy based on agriculture, handicrafts, and trading, and supported by slavery. Slaves were taken from rival city-states defeated in war. Most people were not taught to read or write. Freeborn men could attend academies and become well-educated in literature, philosophy, mathematics, and science. Freeborn women might have learned to read at home but were taught mainly domestic skills.

During Agnodice's time, there was a law which protected the privileges of male doctors by forbidding freeborn women and slaves from practicing medicine. Agnodice wanted to become a doctor, so she dressed up in men's clothes and went to Alexandria, an important scientific center in Egypt, to learn medical skills. She studied with Herophilus, a learned anatomist and physician.

When she completed her training, Agnodice returned to Athens and began to give medical care to women. Since word of her competence traveled quickly, there was great demand for her services. But her success was viewed as a threat by male physicians concerned about maintaining their earning power. Thinking that Agnodice was a man, they denounced the new doctor for ruining their wives' reputations. Agnodice then revealed herself as a woman, and as a result was prosecuted for breaking the law that limited medical practice to men.

When she was put on trial most of the noble women of the city went before the judges, who were their husbands, arguing that the judges would be acting as enemies if they condemned Agnodice since she had done so much to save their lives. The women also said they would die with Agnodice if she were condemned.

As a result of pressure from these women, the judges changed the law to say that freeborn women could study and practice medicine for pay ---but could treat only women. Thereafter, many ancient Greek women could legally study, practice, and write about medicine. They worked and taught all over Greece, Egypt, and western Asia.

"...we can quote the example of Cleomenes, of whom Herodotus says, 'he died childless, leaving an only daughter called Gorgo,' and observe that in modern Greece a man habitually ignores his daughters when enumerating his children."

--- W.K. Lacey, The Family in Classical Greece, 1968

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ASPASIA
physician

2nd century A.D.; Roman Empire

Aspasia was a doctor who lived during the second century A.D. She specialized in obstetrics, gynecology, and surgery. Most of her writings have been lost, but we know about her from later medical writers, particularly Aëtius, who lived in Mesopotamia in the 6th century A.D.

Aëtius praised Aspasia for her great knowledge and skill in diagnosing fetal positions, treating dysmenorrhea (painful menstruation), and performing podalic version (turning a sideways fetus in the uterus by seizing the feet). She advocated eating sparingly and avoiding violent exercise during pregnancy.

In most of her treatments, Aspasia suggested the use of herbs. Aëtius described Aspasia's method of managing difficult labor with treatments that included application to the vulva of hot lotions made from olive oil, mallows (a kind of plant), flax seed, herbs, and the oil from a swallow's nest. She also devised treatments to prevent conception for women for whom pregnancy was a serious hazard.

Aspasia formulated directions for inducing abortions and suggested treatment for malpositions of the uterus. She performed and gave instructions for a variety of surgical operations; and she treated varicosities (expanded blood vessels) of the uterus by surgery. In addition, she dissected the intestines for hernias, closed wounds with two or three sutures (stitches), and provided postoperative advice.

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"EARLY GRAVESTONE OF A WOMEN PHYSICIAN" deleted from this page due to copyright restrictions.

The physician Aspasia should be distinguished from another Aspasia who lived in Athens in the 5th century B.C. The earlier Aspasia was a learned woman, born in Ionia, who taught, wrote, and hosted educated people in her Athens home. She was one of the heterae, educated women who were brought to Athens, often as slaves, and were companions to upper class men. Aspasia argued for equality of the sexes and influenced the thought of the general and statesman Pericles, the philosophers Socrates and Plato, and some of the dramatists of her day. She was married to Pericles and is said to have written some of his speeches. (See Mozans, Woman in Science; and Osen, Women in Mathematics.)

HYPATIA

mathematician, inventor

c. 370-415 A.D.; Alexandria, Egypt

Hypatia's parents planned to educate her to be a "perfect human being." Her careful upbringing developed her many talents and she was able to make contributions to the fields of geometry, algebra, philosophy, and astronomy.

Hypatia was born in Alexandria, Egypt. Little is known about her mother. Her father, Theon, was a distinguished teacher of mathematics at the University of Alexandria, the cosmopolitan seat of learning where scholars from all over the Roman Empire exchanged ideas. During the several centuries of the Greek and Roman eras, some philosophical schools such as those begun by Pythagoras (sixth century B.C.) and Plato (427-347 B.C.) provided a favorable climate for a few women to pursue academic interests. Hypatia, under the structured guidance of her father, was one of these women.

Theon was both a tutor and a companion to his daughter. He set up a rigorous program of physical training for her to complement her arduous mental work. In addition to daily calisthenics, rowing, swimming, riding, and climbing, she learned forensics (debating), philosophy, astronomy, astrology, and mathematics. After this formal training, she traveled abroad, and then returned to teach mathematics and philosophy at the University of Alexandria. Her home as well as her lecture room were visited by the best thinkers of the day, and she became known to some as "The Oracle" or "The Muse."

Hypatia wrote several treatises, of which only fragments remain. Most were prepared as textbooks

Illustration by Leslie Snodgrass, 1976

HYPATIA

(c. 370-415)

in mathematics and philosophy. Hypatia was also an inventor. The philosopher Synesius of Cyrene, a student of Hypatia, credited her with the development of an astrolabe and a planesphere (both instruments used to study the stars). Synesius wrote that Hypatia also developed a device for distilling water, an instrument for measuring the level of water, and a hydroscope (an instrument for measuring the specific gravity of water).

"As decidedly as that two and two make four, what a monstrocity is a woman who is a professor of mathematics, and how unnecessary, injurious, and out of place she is."

---August Strindberg (1849-1912),
Swedish novelist and dramatist

Although Hypatia never married, it is said that she had relationships with men and a number of marriage offers from philosophers and princes. Her answer to marriage proposals was that she was "wedded to the truth."

Hypatia's life had a violent end. In 412 A.D. a man named Cyril became the patriarch of Alexandria. As a Christian he thought that neo-Platonism was heretical, and he began a systematic oppression of such believers. Because of Hypatia's adherance to neo-Platonism and because of her friendship with Orestes, the ruler of Egypt, who was a power threat to Cyril, she became the victim of religious and political conflict. On her way to the University, she was dragged from her chariot by a mob and tortured to death under Cyril's direction.

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TROTULA

physician

11th century; Italy

Trotula has been regarded by many writers as one of the greatest medical women of Italian history. Little is known about the details of her life, but she has been described as a keen observer, a skilled midwife, and an important writer.

Trotula lived at a time when plagues threatened Europe and there was a shortage of medical practioners. A number of well-to-do Italian women ---usually wives, widows, sisters, and daughters of physicians---were able to study and practice medicine. Most did not attend medical school, but trained with their relatives.

Trotula was a member of an old noble family, the Ruggieris, of Salerno, a city near Naples. During her lifetime, communities in Italy, France, and England were experiencing a rebirth of knowledge after the centuries known as the Dark Ages. Salerno was an active intellectual center---traffic between Western Europe, Asia, and Africa met there, resulting in the exchange of ideas and written works between Christians, Jews, and Arabs.

Salerno was the site of the earliest non-religious medical school in Europe, and it was there that Trotula studied and taught medicine. The school was begun in the eleventh century as an informal, voluntary assembly of lay masters and students. At first women participated as students and teachers, with principle responsibility for gynecology and obstetrics. Two centuries later, when medical people were more numerous and more competitive, degrees and licensing became more formalized, and women were excluded from medical education and practice.

"As regards the individual nature, woman is defective and misbegotten, for the active power in the male seed tends to the production of a perfect likeness according to the male sex; while the production of women comes from defect in the active power, or from some material indisposition; or even from some external influence, such as that of a south wind, which is moist, as the Philosopher [Aristotle] observes."

---St. Thomas Aquinas, Summa Theologica, 13th century

Trotula practiced and wrote in collaboration with her husband, Giovanni Platerio, and one of her sons who was a surgeon. They compiled an encyclopedia of medicine, Practica Brevis, for their students. They also put together a useful work, De Compositione Medicamentorum, on the compounding of medicines. Since mechanical printing had not yet been developed, these books had to be copied by hand during the next few centuries.

The Catholic Church prohibited dissection of the human body during Trotula's time, so people used other methods for studying diseases. Trotula based her diagnoses on observations of the urine, pulse, skin, and facial expression. Her treatments included use of herbs, medicinal baths, salves, and bleeding. Trotula was skilled at surgery and could lance an abscess, perform a Caesarian section, and repair a rupture in the perineum (the pelvic area). She emphasized making patients comfortable, and she avoided recommending costly cures for poor patients.

Trotula's gynecological work, De Mulierum Passionibus (On the Suffering of Women), is the

earliest complete compendium of women's healthcare that has come down to us. The book included the medical findings and treatments of classical Greek, Roman, and Arab authors, as well as newer ideas and techniques. Trotula discussed the hygiene of pregnancy and childbirth, relief of painful menstruation, treatment of sterility, care of newborn babies, treatment of skin ailments, and ways to improve the complexion.

At first hand-copied in Latin, the book was set in type in 1544 and then went through numerous reprintings and translations. During the next 300 years medical practioners in many parts of Europe relied upon the information that Trotula recorded about women's healthcare.

"I say it to thee again, and doubt never the contrary, that if it were the custom to put the little maidens to the school, and they were made to learn the sciences as they do to the men-children, that they should learn as perfectly, and they should be as well entered into the subtleties of all the arts and sciences as men be."

---Christine de Pisan, La Cité des Dames (The City of Women), 1407

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HILDEGARD of **BINGEN** healer, writer

1098-1179; Germany

Some of the most extensive scientific works of the Middle Ages were written by the Abbess Hildegard of the Rhine country. She was also a philosopher and a politician.

Hildegard was born in 1098 at Boeckelhein near the Rhine River. She was the youngest child in a large noble family. At the age of eight she was sent to a convent to study, the only place where a girl could become educated during the Middle Ages.

As a child Hildegard began to have visions or daydreams preceded by flashes of lightning. It is thought that she may have been a victim of migraine or epileptic attacks. Her contemporaries viewed her as possessing spiritual gifts evident in these visions. She later recorded many of her scientific ideas in the form of visions.

As an adult, Hildegard was the head of a small convent on a hilltop above the German Rhine. From there she travelled by horseback through Germany and France to teach about medicine and theology in monasteries and other church institutions. She also corresponded with popes, emperors, and kings, sometimes influencing their actions. She foretold the downfall of the Holy Roman Empire and predicted that a reformation of the Catholic Church would result from the corruption of the clergy.

Hildegard was skillful in observation and diagnosis of disease, and she had a reputation as a competent healer. She probably had access to the medical texts which had been prepared in

recent centuries by physicians in Salerno, Italy, and other medical centers. Hildegard prescribed medicines in small doses with much water, suggesting inexpensive medicines for the poor. She had practical knowledge of over 400 plants and drugs which she thought were useful for treating diseases. At a time when most medical practitioners used unsterile methods of treatment, Hildegard believed in assuring cleanliness. She was also careful to recommend proper diet and exercise.

Hildegard's writings, consisting of fourteen books, some of several volumes, cover a wide range of topics. In one encyclopedic work, known

"HILDEGARD'S FIRST SCHEME OF THE UNIVERSE" deleted from this page due to copyright restrictions.

as the Physica, there are references to nearly 500 plants, metals, stones, and animals, including their value as medicines. Hildegard also wrote on subjects such as zoology, botany, folk medicine, psychology, and human anatomy. She foreshadowed later theories about the circulation and chemistry of the blood, the causes of contagion, and the transmission of nerve action from the brain. In a work known as Scivias she wrote about her visions and religious beliefs.

Hildegard believed in the interrelationship between the whole and the parts-of-the-whole ---between the macrocosm (an earth-centered universe) with it's "world spirit," and the microcosm (an individual person). Basing her ideas on fragments of writings from ancients such as Aristotle (384-322 B.C.) and Galen (131-c. 210 A.D.), on Biblical sources, and on early Church writers such as St. Augustine (354-430 A.D.), as well as on her own experience, Hildegard generated a systematic and complete philosophy which shows her genius for her time. She lived too early to benefit from the knowledge which flowed from Arabia through Paris into Europe during the thirteenth century. With this knowledge, her contributions would probably have been greater.

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JACOBA
FELICIE
physician

13th century; Paris, France

Jacoba Felicie, a noble woman born in Florence, Italy, and living in Paris, was one of many healers prosecuted for practicing medicine without training at a university. The medical community of thirteenth century Paris was much more restricted than that of most Italian cities, where women could attend and teach at medical schools and could practice medicine without a university education.

The Faculty of Medicine at the University of Paris was staunchly opposed to female physicians and wished to maintain its control over medical work. In 1220 an edict was written prohibiting anyone not on the faculty, which was completely male, from practicing medicine.

The edict was not enforced for a long time, but in 1322 it was used against Jacoba Felicie as well as against several other women and men. Jacoba was charged with examining sick persons, prescribing remedies, curing patients, and receiving fees when she had not studied at the Medical School of Paris, had not been licensed, and had been warned not to practice medicine. The Dean and Masters of the Medical School claimed that she was not competent to practice medicine because she did not know the causes of disease, which they said had to be learned from books.

"God created Adam lord of all living things, but Eve spoiled it all."

--- Martin Luther (1483-1546)
German religious reformer

Reprinted from Ehrenreich and English, Witches, Midwives, and Nurses (Feminist Press, 1973) p. 16

THE LADY AS PHYSICIAN (15th century). She prepares medicine, following a prescription in a book on her knee. A nurse stands by.

Jacoba and several of her patients pointed out that she had effected cures after university-trained physicians and their "scientific" methods had failed. She argued that the law of 1220 was intended to pertain to ignorant persons who knew nothing about medicine. She also said that it was more suitable for women to be treated by a female doctor.

Despite Jacoba's demonstrated competence as a healer, and even though her procedures of diagnosis and treatment were the same as those of master physicians of Paris, Jacoba and others

charged with the same "crime" were fined heavily and prohibited from practicing medicine in or near Paris, under threat of excommunication. Not until 1868 did the Medical School of Paris admit women; and for twenty years thereafter, female physicians still could not serve as interns at Paris hospitals.

"We must never confuse professionalism with expertise. Expertise is something to work for and to share; professionalism is--by definition--elitist and exclusive; sexist, racist, and classist."

---Barbara Ehrenreich and Deirdre English, Witches, Midwives, and Nurses: A History of Women Healers, 1973

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EMILIE du CHÂTELET

mathematician, physicist

1706-1749; France

During the seventeenth and eighteenth centuries in France, women were valued highly for their beauty and social graces. A certain amount of education was an asset, but serious study was not considered appropriate for women. Women who revealed their knowledge became objects of literary satire; being a learned woman carried a social stigma.

There were some exceptional women who combined learning with the proper womanly social graces. As hostesses, they created important salons---meeting places where the men and women who visited could discuss current ideas in philosophy, science, and the arts. In general, however, women were believed incapable of abstract thinking, and special bookes "for the ladies" were written to explain new discoveries in science.

Emilie du Châtelet was born into this milieu in 1706, a member of the wealthy de Breteuil family. Her father, a baron, provided her with a good education and appreciated, even in a daughter, what appeared to be scientific genius. Emilie learned to speak and write several languages, and she was interested in philosophy. But her first and lasting intellectual love was mathematics.

When she was nineteen Emilie married the Marquis du Châtelet and enjoyed a social life centered on the French court. Her love of gambling and romantic adventure made her private life the subject of gossip, although her activities were not unusual in her social circle.

"The education of women should always be relative to that of men. To please, to make us love and esteem them, to educate us when young, to take care of us when grown up, to advise us, to console us, to render our lives easy and agreeable. These are the duties of a woman at all times, and what they should be taught in their infancy."

--- J.J. Rousseau, Emile, 1762.

Emilie's intellectual life, however, was exceptional. She made what is still the only French translation of Isaac Newton's Principia (first published in 1686). This project required a thorough understanding of the Latin original as well as of the complexity of the new ideas of mathematics, physics, and astronomy set forth in Newton's book. Emilie added to the translation an "Algebraical Commentary" of complex mathematical concepts. She also wrote essays on the philosophy of Gottfried Leibnitz (1646-1716); and a dissertation on space, time, and force. In the latter work she anticipated future conclusions regarding the nature of energy.

The gossip about Emilie's private life was not unfounded, for she had numerous relationships with men. One of these was with the eminent philosopher and dramatist Voltaire (1694-1778), who became her lifelong companion and lived with her at the Châtelet home in Cirey. Here they were visited by some of the greatest thinkers of the day. Emilie and Voltaire set up a laboratory with an extensive collection of equipment and materials where they could perform scientific experiments. In 1738, when Emilie disagreed with a paper on the nature of fire that Voltaire was writing for a competition of the French Academy

of Science, she prepared her own paper to enter in the contest. Neither paper won the prize, but both were praised and were published by the Academy.

Emilie was strongly attracted to frivolous court life. She was known to have danced, feasted, and gambled until dawn. Upon rising, she would work out intricate mathematics problems before breakfast. Sometimes she worked late into the night, plunging her hands into ice water to keep herself awake. She wrote a controversial essay on happiness in which she argued that people have nothing to do in this world but pursue agreeable sensations--- an adequate description of the way she lived. Her pursuit of mathematics and science was, however, as much a part of her idea of pleasure as more conventional "feminine joys"; her intellectual work was an important aspect of her flamboyant and enthusiastic approach to life.

Emilie du Châtelet died after childbirth when she was forty-three years old. Voltaire described the birth occurring as Emilie sat at her desk, writing about Newtonian theories. While her death by childbirth was tragically typical of women in her time, her life---open and intellectual--- was atypical of her expected role.

"The glory of a man is knowledge, but the glory of a woman is to renounce knowledge."

--- Chinese proverb

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MARY FAIRFAX
SOMERVILLE
physicist, astronomer

1780-1872; England

Like many girls born in the 1700's, Mary Fairfax received no formal education other than learning to read the Bible. Mary was born in Scotland where her family lived throughout most of her childhood. Her father, Sir William Fairfax was a vice-admiral in the British Navy. Mary was ten years old when she was sent to Miss Primrose's local boarding school to learn domestic skills.

In her early teens she became fascinated with mathematics when she happened across a mathematical puzzle printed in a ladies' journal. She began her mathematical education through algebra and geometry books smuggled to her by her brother's tutor. When her parents discovered these activities they were horrified. Attempting to curtail her interest, they confiscated her candles, preventing her from studying at night. But by this time she had read and could recall by memory the first six books of Euclid's Geometry, an important ancient work.

Mary was married to a well-to-do man in 1804. Her husband held intellectual women in low esteem and she was temporarily dissuaded from her studies. At the death of her husband three years later, she was for the first time economically independent and began studying in earnest.

When Mary submitted a prize-winning essay to a popular mathematics journal,the editor, to whom Mary had confided her determination to learn mathematics, recommended the classics necessary to build a mathematical foundation. She was thirty-three when she acquired her small library.

She had two children who occupied her days, but in the evenings she rigorously applied herself to the study of mathematics.

In 1812 Mary remarried. Her second husband, Dr. William Somerville, was a scholar and a reasonable man. He encouraged Mary's endeavors, reading proofs, checking manuscripts, and helping her to search libraries. Through her husband, she came in contact with many eminent scientists and intellectuals of her time. She soon became reknowned for her ingenuity and intellect.

There little girl, don't read
You're fond of your books, I know
But brother might mope
If he had no hope
Of getting ahead of you.
It's dull for a boy who cannot lead
There, little girl, don't read.

---Anon.

Mary was one of the first scientists to perceive the underlying common principles applying to seemingly dissimilar physical phenomena--magnetism, electricity, chemical change, heat, and mechanical work. Her effort to develop conversion processes to relate these phenomena was a beginning step toward the concept of conservation of energy which was formulated by later theorists.

In addition, Mary's astronomical work led to an important discovery. While reviewing a paper on planetary theory which discussed the irregularities in the motion of the planet Uranus, Mary hypothesized that the irregular motions might be due to an unseen planet revolving around the sun, but outside the known solar system. A young mathematician read her hypothe-

sis and was able to confirm it and predict the existence of the planet Neptune. This prediction of the position of a not-yet-known planet marks one of the highpoints of nineteenth century astronomy.

Mary became the best known science popularizer of her time. The French scientist Marquis de Laplace (1749-1827) wrote a treatise on physical astronomy which continued Isaac Newton's search for a physio-mathematical theory to account for the motions and positions of the major astronomical bodies in the solar system. It was confidently stated that only ten men in France and half that many in England could read and understand what Laplace wrote. Mary recognized the importance of the work for the nonscientist as well as for her scientific colleagues, and she proceeded, in her own words, to "simply translate Laplace's work from algebra to common language."

"All abstract speculations, all knowledge which is dry, however useful it may be, must be abandoned to the laborious and solid mind of man.... For this reason, women will never learn geometry."

--- Immanuel Kant (1724-1804)
German philosopher

Throughout her life, Mary continued to make scientific ideas available to nonscientists, especially to women, who like herself had been deprived of an education. She prefaced one of her books with her intent, "to make the laws by which the material world is governed more familiar to my countrywomen." Mary was able to relate complex phenomena in a simple way that was understandable to nonscientists. Among her highly successful books were The Connexion of

the Physical Sciences (1834), Physical Geography (1848), and Molecular and Microscopic Science (1869). Her expertise was very broad, ranging from astronomy and physics to meteorology, oceanography, and zoology.

Mary continued her work until the day of her death at age ninety-two. In 1835 Mary and Caroline Herschel* were elected honorary members of the Royal Astronomical Society, the first women to be admitted to a British science society. Though Mary received great recognition in her lifetime, she did so despite prejudice and adversity. We can only speculate what her fertile mind and boundless energy could have accomplished if she had received the same encouragement and education available to her male counterparts.

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* For more information about Caroline Herschel, see page 70 of this booklet.

MARIA
MITCHELL
astronomer

1818-1889; U.S.A.

Maria loved light and colors as did her father, the astronomer for the whaling town of Nantucket, Massachusetts. Their Quaker faith limited this eye for color to the garden and, of course, the night sky. Although Maria could not abide by the strictest discipline of the Quaker school she attended as a child, she was a quick and energetic learner and she developed an avid interest in astronomy.

By day, Maria would go to school and, when she was older, to work at the Nantucket Library, but every clear night she would "sweep the skies" from the rooftop of her parents' home. Maria didn't attend college---not because her family couldn't afford it, but because there was only one college, Oberlin in Ohio, that accepted women at that time. Maria was lucky to have parents interested in educating all their children, and a built-in apprenticeship in astronomy with her father.

"Marriage?
I'd rather be a free spinster and
paddle my own canoe!"

---Louisa May Alcott (1832-1888)
American author

In 1847, at the age of twenty-nine, Maria sighted the first comet to be discovered with a telescope. She received a medal from King Frederick VII of Denmark for her finding and was invited to join the American Academy of Scien-

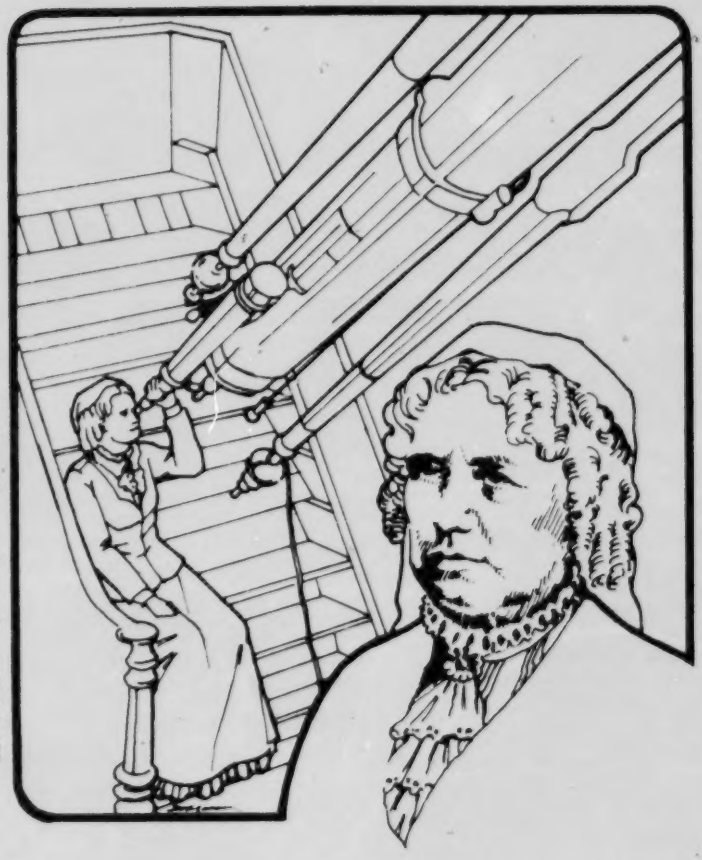

Illustration by Leslie Snodgrass, 1976

MARIA MITCHELL

(1818-1899)

ces, the first woman to get this honor and the only woman for many years.

With the opening of Vassar College in New York in 1865, Maria was asked to join the faculty and she taught women for the next twenty-three years of her life. She was an excellent teacher, inspiring her students with her energy and insisting that they question everything. She would tell her students about scientists of the past and astronomers she had personally known, including Mary Somerville[1] and Caroline Herschel.[2] Her students included the prominent chemist Ellen Swallow[3] and twenty-five other women eventually noted in Who's Who in America.

"Until women throw off reverence for authority they will not develop. When they do this, when they come to truth through their own investigations, when doubts lead them to discovery, the truth they get will be theirs, and their minds will go on and on unfettered."

--- Maria Mitchell (1818-1889)
from her diary.

Maria was a member of the group of women who started the Association for the Advancement of Women in 1873. At a time when the women's suffrage movement actively sought the vote for women, the Association for the Advancement of Women worked toward educational reform. Maria soon became president of this organization and lectured all over the United States on the need for higher education for women.

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[1]See page 27 of this booklet.
[2]See page 70 of this booklet.
[3]See page 40 of this booklet.

Maria's ideas on education were sometimes viewed by conservative men as a palatable approach to equality for women. Following a congress of women initiated by Maria, the Chicago Tribune reported, "Maria Mitchell is well known as one of the cleverest and clearest thinkers and workers of the day. These women of the Congress seem to be working more rationally for their sex, and infinitely more successfully than some of the suffragists who have only one thought ---the ballot box...."

Maria retired from Vassar in 1888 and died the following year. She saw many of her students succeed in the sciences and other fields where women had rarely participated. Maria never gave up her astronomy and she continued to sweep the skies until a few months before her death.

"I ask no favors for my sex. I surrender not our claim to equality. All I ask of our brethren is that they will take their feet from off our necks..."

--Sarah Grimke, 1838
American abolitionist
and feminist

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FLORENCE
NIGHTINGALE
nurse

1820-1910; England

Florence Nightingale has been the subject of countless biographies and has served as a role model for young women for many years. Referred to as the "Lady with the Lamp," she is often romanticized as a selfless and devoted hospital servant. It would be more realistic, however, to describe her as largely responsible for improvements in the quality of hospital sanitation and nursing care during the second half of the nineteenth century.

Florence was born in England in 1820, the second daughter of aristocratic parents. Her mother descended from an old wealthy family. Her father inherited much of his money from an uncle. Since her father had no sons, family tradition directed his inheritance to his sister's son.

Florence's early years were filled with playmates, toys, and ponies, but Florence was not happy with childhood games. She often daydreamed about serious philosophical ideas, and her passion for living and learning made her feel different from other children. Her father loved children and "Flo" spent a great deal of time with him. At an early age she dominated and led the activities that included her older sister.

Florence's parents could not agree on the proper education for their daughters. Their father wanted a governess with high intellectual capabilities, while their mother wanted a governess with a high standard of elegance. Finally, in 1832, they hired a governess to teach music and drawing. Florence's father taught the girls Greek, Latin, German, French, Italian, and his-

tory. Florence proved to be an excellent and diligent student. She hated the social obligations of the time (writing letters, for example) and she wrote in her diary that she longed for "some regular occupation worth doing instead of frittering time away on useless trifles."

Sugar and spice
and everything nice
That's what little girls are made of.

Delicacy was the universal code for women at this time, and romanticism was in vogue. Rigid respectability governed women's behavior; women were expected to expend their emotions on everyday events. The naughtiness of a child, a misunderstanding between friends. the non-arrival of a letter were thought to necessitate smelling salts, darkened rooms, and a soothing drink. Florence, like all aristocratic girls at that time, was brought up with these ideas, but she began to believe that her life had a greater purpose.

According to Florence's diary, on February 7, 1837, God spoke to her and asked her to work in his service. How she was supposed to do this was not explained, but she had faith that she would learn in time. For two years she participated in the social activities appropriate for women of her class. Then she became distressed that she did not know what God wanted of her. She began to study archaeology and religion, and soon became accepted as an intellectual in high society.

As she travelled in 1842, Florence became aware of misery and starvation in the world. The 1840's were a time of starvation and illness for England. After caring for many sick friends and relatives, Florence realized that her destiny was working in a hospital with the ill.

At that time hospitals were places of wretchedness and squalor, housing dying poor people but offering little treatment. Most nurses were poor women who could get no better jobs. They were untrained, often considered immoral by the standards of the day, and sometimes not sober. Flo's parents were irate when she told them of her plans and they forbade her to consider working in a hospital. She became depressed and withdrew into herself. She began to read everything about hospitals that she could find. She traveled with her family, secretly visiting hospitals, and continued to nurture her dream.

"This world taught woman nothing skillful and then said her work was valueless. It permitted her no opinions and said she did not know how to think. It forbade her to speak in public and said the sex had no genius. It robbed her of every vestige of responsibility and then called her weak."

---Carrie Chapman Catt (1859-1947)
American suffragist

After many more frustrating years of arguing with her family, Florence was finally allowed to go to Kaiserwerth, a hospital in Germany, to learn about nursing. There was little formal or informal nursing education available, but at last she was permitted to do what she wanted.

Florence had been working in a nursing home in England for about a year when the Crimean War broke out in 1854, with England and France fighting Russia. Florence's friend Sidney Herbert, an aristocratic politician who was her lifelong advocate, was in the War Office at the time. He suggested that she go to Scutari, a village on the Asian shore of the Bosporus Sea,

where an English base had been established. Florence organized a group of nurses to make the trip.

The conditions at the Scutari hospital were deplorable. Florence organized the kitchens to provide soldiers with adequate meals and arranged the laundry to provide clean linen regularly. Sanitation precautions were begun and medical supplies purchased, primarily with funds raised by and entrusted to Florence. As conditions improved in that hospital, she began inspecting other hospitals in the area, making suggestions and setting up standards.

After the war, Florence went home to England. Her health was poor and she was advised to rest and recuperate. But she continued to work to bring about hospital and city reform. She had the help of Sidney Herbert and a "cabinet" of friends and officials who believed in her cause. Such supporters were necessary because at that time it was unthinkable for a woman to sit on governing councils.

"Sexism, like any other cultural characteristic, lives through institutions -- those that blindly perpetuate it and those that depend upon it for their very life."

---Vivian Gornick and Barbara Moran, Introduction, Woman in Sexist Society, 1971

Florence became a powerful and respected person, an advisor on training nurses and improving hospitals. Her life was long and full, and shortly before she died at the age of ninety, she was awarded the Order of Merit by the throne of England.

Although Florence was an active woman and a successful hospital reformer, she perpetuated the nineteenth century aristocratic view of women as nurturing, serving, and subsidiary. She saw nursing as an appropriate "women's job" and thought that the few women of her day who studied and practiced medicine were "trying to be men." She accepted the hospital hierarchy which gave male doctors a dominating role and female nurses a secondary status. The nursing role set by Florence and other hospital reformers of her time is one of the problems faced by modern women trying to achieve equality in the healthcare system, and trying to break down the hierarchical organization of healthcare jobs.

"Boys are doctors. Girls are nurses. Boys invent things. Girls use what boys invent."

---Whitney Darrow, Jr., I'm Glad I'm a Boy! I'm Glad I'm a Girl, 1973

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ELLEN
SWALLOW
chemist, environmentalist

1842-1911; U.S.A.

Ellen Swallow, who popularized the word "oekology" (now, ecology), devoted her life to studying and teaching about healthful environments. The first woman to attend and teach at a science college, Ellen paved the way for other American women to become scientists.

Ellen was born near Dunstable, Massachusetts. As an only child she got a great deal of attention from her parents. Being fairly well-educated themselves, Ellen's parents tutored her in their home for the first sixteen years of her life. This was a common practice in Massachusetts since public education was not yet mandatory. Ellen's father taught her history and logic; her mother taught numbers and letters. At that time most people thought that domestic skills were all-important for women, and Ellen, as a matter of course, learned her share.

When Ellen was seventeen, her parents moved to Westford, a town a few miles away, so she could attend Westford Academy. Ellen had the opportunity to demonstrate her brilliance in mathematics as well as all other subjects. When she graduated from the academy at the age of twenty-one her parents moved again, this time to Littleton, Massachusetts, in order to buy a bigger store. Ellen managed the post office substation attached to the store, and the next year she took a teaching job two miles away.

Then Ellen moved on her own to Worcester, Massachusetts, where she worked in a mission school. Leaving home and parents at that time was scandalous for a young woman, but Ellen ignored the "provincial stigma." As far as men were con-

Illustration by Leslie Snodgrass, 1976

ELLEN SWALLOW

(1842-1911)

cerned, Ellen wrote: "I know of no lady with whom I would exchange places. The gentleman whom I think the most of and who comes nearest to my ideal... does not treat his wife as I wish to be treated...I often tell him we could not live together...more than a week." As for children, "...the world will be peopled without my help."

Along with Ellen's desire to learn was her wish to be of use in the world. She saw miseries in jails, hospitals, asylums, and even among her friends. She became more and more frustrated serving as the "town tutor" because no one was able to teach her. But there were no colleges for women in New England; it would be more than ten years before Wellesley or Smith would open.

Then Ellen read about a beer brewer and banker, Matthew Vassar, who had established a "higher education school for women" in Poughkeepsie, New York. In 1868, at a time when some were arguing that the female nervous system could not adapt to higher learning, Ellen entered Vassar College. She began as a third-year student, and two years later was in the first graduating class. While in school Ellen lived frugally, supporting herself by tutoring. She studied astronomy with Maria Mitchell* but decided to do most of her coursework in chemistry since that science could better be put to the services of people.

After she graduated, Ellen sought a job as a chemist but was told that the "hard science" of chemistry was not open to women. She wrote to the heads of several chemical companies who responded that they did not hire women. They suggested that she contact the Massachusetts Institute of Technology to continue her studies.

It was well known that the Institute, then five years old, did not admit women; but Ellen

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*For more information about Maria Mitchell, see page 31 of this booklet.

was determined. She wrote to M.I.T. giving her references from Vassar College. In December 1870 she learned that the M.I.T. faculty had recommended her admission as a special student in chemistry. Since M.I.T. did not want to be obligated to Ellen, they admitted her without charge as the "Swallow Experiment." The "experiment" succeeded, and in 1877 M.I.T. began to admit women as regular students.

While still a student, Ellen gained a reputation for being a diligent, careful, and intelligent scientist. Because she wanted to avoid criticism, she did not speak out on behalf of women's rights. Instead, she maintained the traditional role of a helpful woman by cleaning apparatus and sewing on buttons for the men in the laboratory.

In 1873, Ellen received a Bachelor of Science degree from M.I.T. as well as a Master of Arts degree from Vassar, awarded for isolating the metal vanadium from a sample of iron ore. Though she continued in graduate school at M.I.T., she never received the doctorate she hoped for---apparently because the heads of the department did not want to give M.I.T.'s first doctorate in chemistry to a woman.

"It is only too obvious that a man has no obligation whatever to a woman who is considered brilliant. To such a woman a man can be ungrateful, treacherous, and even mean, and no one will think of taking her side."

---Madame de Stäel (1766-1817)
French writer

When Ellen was a student at M.I.T. she came close to discovering two previously unknown chemical elements. Rather than pursue this chemical analysis, however, she decided to work on research which could improve people's lives. During her long and active life she conducted water purity surveys for the State of Massachusetts, served as an advisor in sanitary engineering to over 200 corporations and schools, set up a public kitchen to demonstrate nutritious cooking, and consulted on school lunch programs. The home Ellen shared with her husband, M.I.T. mineralogist Robert Richards (whom she married in 1875), was itself a laboratory where she experimented with her theories about healthful air, water, illumination, and food.

In her work Ellen was discriminated against as a woman. In most projects her title was "assistant" instead of "director"; often she wasn't fully credited for research, though she did most of the work. Sometimes she worked without pay. Eventually, in 1883, she was named instructor in sanitary engineering at M.I.T., and she remained in that post until her death.

"Mother, what is a Feminist?"
"A Feminist, my daughter,
Is any woman who cares
To think about her own affairs
As men don't think she oughter."

--- Alice Duer Miller, 1915.

Ellen had a notion that "oekology" should be an inter-disciplinary and practical field of science, available to the general public. But this view was not shared by most members of the scientific community. Ellen's idea of oekology was too advanced for her time; many scientists then (and now) preferred to specialize in one field or another and keep their ideas within

"the profession." Some areas of oekology---for example, zoology and botany---were preserved as mostly male academic departments at universities. So Ellen directed her energies to developing a new field, home oekology, which became home economics--- and has remained a "woman's domain."

Throughout her life Ellen was committed to advancing the education of women. While an undergraduate at M.I.T., she helped to teach an experimental course in chemistry at Girls High in Boston to a class of women, half of whom were already teachers. Later, from 1877 to 1883, she served as assistant director (without pay) for M.I.T.'s Women's Science Laboratory, the first of its kind in the world. In facilities set up in an old garage, young women could study chemical analysis, industrial chemistry, mineralogy, and biology. Ellen also developed curriculum materials for the Society to Encourage Studies at Home, a correspondence school for women, and she personally exchanged letters with many women who enrolled in courses.

In 1882 Ellen was involved in founding the Association of Collegiate Alumni, which became the American Association of University Women. Twenty-six years later, Ellen helped to organize the American Home Economics Association. In addition she wrote numerous books and magazine articles on the science of cooking and sanitation, so she could share her findings with women beyond the walls of the university.

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BEATRIX
POTTER
botanist, author

1866-1943; England

Beatrix Potter is known to children and adults alike as the creator of Peter Rabbit and his adventures, as well as of other animal tales. What is not often known is that Beatrix was at one time engrossed in scientific study and was sufficiently discouraged, frustrated, and thwarted by some of the scientists of her day to abandon these endeavors in favor of children's literature.

Born in 1866, Beatrix was the daughter of well-to-do English parents. As a child she spent most of her days alone in a nursery with a governess to look after her and tutor her. Her minimal education, typical for women of her time, included studies in French and German, and at the age of twelve she began serious drawing lessons. Beatrix's father was a photographer engaged in photographing many famous men of the day, and she often accompanied and silently helped him. Her mother engaged in the societal role expected of her and spent nearly every day making social calls.

Beatrix spent summers in the countryside and as she grew older she began to study fungi, accompanying her observations with precise drawings. Her search for fungi included an increasing interest in the study of lichens. Beatrix was to become the first person in England to affirm that the colorful patches growing on trees were actually a merger of two plants---algae and fungi.

Beatrix described in her journal her exasperating encounters with other scientists, but she

Illustration by Leslie Snodgrass, 1976

BEATRIX POTTER

(1866-1943)

wrote the entire journal in a code that she invented when she was a child. We now know how she was treated by these men only because the journal was found and laboriously deciphered by a scholar studying Beatrix's life and work.

Encouraged by her uncle, Sir Henry Roscoe, a chemist knighted for his scientific contributions, Beatrix pursued her studies and made several attempts to share and discuss her work with noted scientists of her day. Her uncle accompanied her to the Royal Botanical Gardens when she tried to present her ideas to the director, Sir William Thistleton-Dyer. Thistleton-Dyer belittled her studies, maintaining that her drawings were "too artistic to be scientific," and left Beatrix without giving her an opportunity to explain her work. He ended the conversation by turning to Roscoe and did not address Beatrix again.

"We are willing to share our great thoughts with mankind. However, you happen to be a girl."

---a boy in the story "Curious Annabelle," elementary reader Ventures (Book 4), 1965

Roscoe further encouraged Beatrix to write a theoretical paper about fungi which she also tried to present to Thistleton-Dyer. At the first attempt, which she made without the company of her uncle, she fled in shyness, but on the second attempt she was brave and confident enough to scoff at his negative comments. Thistleton-Dyer suggested that her ideas were "mare's nests" and that she should go to Cambridge University for proper schooling. Beatrix informed him that, "It will all be in the books in ten years," and left.

Enraged by a nasty letter from Thistleton-Dyer, Roscoe carefully assisted Beatrix through

several drafts of a final scientific paper, insisting on perfection. This paper was presented in 1897 to the prestigious Linnean Society in London. Ironically, her paper was read by a male assistant from the Royal Botanical Gardens, as women were not permitted in the Society. The paper developed the theory of the positive relationship of fungi and algae in the lichen union, maintaining that the fungi and algae both served a necessary role (called a symbiotic relationship).

Before publishing the paper, Beatrix requested that it be returned, ostensibly to complete her studies. Unfortunately, her work was never finished and was apparently burned along with other papers after her death. With the presentation of her paper in 1897, Beatrix's code journal ends.

During this period and for years afterward, Beatrix found the response from child readers of her animal stories infinitely more satisfying than her negative encounters with the world of science. And so, turning to literature, she spent the remainder of her life in the well-known, highly respected, creative endeavors of her animal tales.

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MARIE SKLODOWSKA
CURIE
physicist

1867-1931; Poland, France

Marie Sklodowska Curie, pioneer researcher in the properties of radioactive elements, was the first woman to receive the Nobel Prize and the first person to receive two Nobel Prizes.

Born in Warsaw, Poland, in 1867, Marie Sklodowska got her science education in France and never returned to live in her native land. Poland was under Czarist Russian rule at that time, and Marie grew up under political oppression that she and many other Polish people intensely resented.

Marie came from a family of the lesser nobility. Her mother died when Marie was ten, and Marie's father, a science professor at a boys' high school, became a guiding force in her life. When Marie was a child, her father was demoted and his salary reduced as a result of his outspoken patriotism for Poland. From then on he was over-worked, giving private lessons to supplement his income. Though poor, he was able to create a rich intellectual home environment for his four children.

At seventeen Marie graduated at the top of her high school class, but she could not afford to go on to college. Besides, the University of Warsaw did not admit women at that time. Marie did private tutoring to earn money, and she attended science and history classes at an informal "university" in Warsaw. She also gave reading lessons to poor women. During this period in her life, Marie realized that humanitarian, patriotic, and socialist values were important to her, as well as intellectual pursuits.

Illustration by Leslie Snodgrass, 1976

MARIE SKLODOWSKA CURIE

(1867-1931)

Then Marie made a pact with her older sister, Bronya, that she would earn money to help Bronya attend medical school in Paris if Bronya would in turn help pay for Marie's university education. Marie worked as a governess in rural Poland for five years

Marie eventually joined her sister and new brother-in-law, also a doctor, in Paris and attended the Sorbonne University. Having little money, she rented a small unheated attic room, and for three years lived a solitary, comfortless student's existence. Perfecting her French, she worked conscientiously and systematically on her science studies. She passed the Masters exam in physics in 1893 and the Masters exam in mathematics in 1894.

Devoted to her work, Marie did not expect to marry. But then she became friends with Pierre Curie, a young physicist and teacher at the School of Physics and Chemistry, with whom she shared humanitarian and scientific visions. When they married in 1895, Marie realized that she would probably never return to teach in Poland.

"If Madame Curie were available only from 10 to 2, would you hire her?"

---from a brochure by Focus on Part/Time Careers, Seattle, Washington, 1975

While having full responsibility for their home and for Pierre's wardrobe, Marie continued her research on steel in a makeshift laboratory set up in a damp storeroom that Pierre was able to find for her at his school. The Curie's first child, Iréne (a future scientist and Nobel Prize winner*), was born in 1897. That same year Marie

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*For more information about Iréne Joliet-Curie, see page 72 of this booklet.

started research on radioactive materials for her doctorate. This work was to occupy her for the rest of her life.

Marie began by investigating the properties of the salts of uranium, a rare metal which emitted radiation of unknown nature and origin. These rays had been noticed by Henri Becquerel, a French physicist, a short time before. In 1898 Marie predicted the presence of a new highly radioactive element, radium, in pitchblende ore residue (what remains after uranium is removed). At this point Pierre gave up his research projects to join Marie's. Using techniques of chemical separation, the Curies concluded that there were two radioactive elements in the pitchblende ore. Marie named the second new element polonium, after her native Poland.

Moving their laboratory to an abandoned shed on the grounds of Pierre's school, the Curies spent the next four years isolating pure radium. Interrupted many times by illness, lack of funds, and inadequate working conditions, they nevertheless worked their way through a ton of pitchblende ore. In 1902 they succeeded in preparing a decigram (ten grams) of pure radium and determining for the first time its atomic weight. For this tedious work, which required skills in chemistry, physics, and engineering, Marie received her doctorate from the Sorbonne in 1903.

The demand for radium grew as its technological and medical uses became known, but Marie and Pierre did not consider their process for isolating the substance their own personal property. Giving up a potentially enormous fortune, they decided not to patent their discoveries and they published all their results. For their achievements the Curies received the Nobel Prize in physics from the Swedish Academy of Science (shared with Becquerel) in 1903; they were awarded the Davy Medal by the Royal Society of London in the same year. Shortly after, however, Pierre refused the French Legion of Honor, since Marie was not also a recipient of the award.

"Women hold up half the sky."

--- Mao Tse Tung

In 1904 the Curie's second daughter, Eve (a future writer), was born. At about the same time Pierre became a Professor at the Sorbonne. After fighting for research facilities at the University, he was granted some space, and Marie was named chief of the laboratory. Two years later, when Pierre was killed in a street accident, Marie was offered his professorship. Though grief-stricken as a result of Pierre's sudden death, Marie accepted the position, becoming the first woman to teach in an institution of higher learning in France.

Marie's scientific work continued during the next few decades, though she was at times in poor health. She extended her studies of radium, succeeded in extracting miniscule quantities of polonium from pitchblende, and helped to develop techniques of radiotherapy (using radioactive materials to treat disease).

From 1909 to 1914 Marie presided over the construction of the Institute of Radium, financed jointly by the Sorbonne and the Pasteur Institute, with facilities for research into the physical, chemical, biological, and medical aspects of radioactive substances. During World War I Marie helped to install and teach people how to use x-ray units in ambulances and battle-front hospitals.

Although Marie received her second Nobel Prize, this one in chemistry, in 1911, she was refused admission to the French Academy of Sciences in the same year because she was a woman. Acclaimed and honored by other science societies all over Europe, she became the first woman elected to the French Academy of Medicine in 1922. She died

in 1931 of leukemia, a disease brought on by the work with radioactive materials that had been such a large part of her life.

"In education, in marriage, in everything, disappointment is the lot of women. It shall be the business of my life to deepen this disappointment in every woman's heart until she bows down to it no longer."

---Lucy Stone (1818-1893)
American suffragist

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MARGARET
SANGER
nurse

1883-1966; U.S.A.

Margaret Higgins Sanger spearheaded the birth control movement in the United States during the first half of the twentieth century. The sixth child of eleven in a poor Irish-American family, Margaret was acutely aware of the helplessness experienced by parents who were too poor to support many children, but who had only a limited knowledge of birth control.

As a young woman Margaret decided on a nursing career---her family couldn't afford to finance a medical school education. While doing postgraduare work at Manhattan Eye and Ear Hospital in 1902, Margaret met and married Bill Sanger, an artist. They had three children---a daughter who died at age five, and two sons.

After ten years of suburban married life, Margaret went back to work as an obstetrical nurse in New York's lower East Side. Her views about the need for an effective, accessible method of birth control were confirmed as she saw mothers die in childbirth or after desperate attempts to abort babies they knew they couldn't feed.

Believing that the world's problems could not be solved as long as food, clothing, and shelter were provided on a competitive basis, Margaret joined the Socialist Party and became active in strike-support work. Sometime later she grew dissatisfied with the Socialist Party's neglect of issues concerning women, and she decided to give her full attention to working for birth control.

In 1914 Margaret started a magazine called The Woman Rebel intended to advocate birth con-

trol and to give readers information about contraception. She was beginning a long career in behalf of birth control. However, information concerning contraception was classified as "obscene," and it was illegal to send obscene material through the mails. When The Woman Rebel was banned from the mails, Margaret began work on a small pamphlet called Family Limitation, which contained contraceptive information she had collected in France and was carefully written so that it could be understood by all women.

"For when we examined gynecology books over time, ranging from the pre-Kinsey era through the allegedly revolutionary post-Masters and Johnson decade, one factor remained constant: anatomy is destiny. Woman is put on this earth to be fruitful and multiply. Her maternal instinct defines her being, unless of course she is 'immature' or 'neurotic.'"

---Diane Scully and Pauline Bart, "A Funny Thing Happened on the Way to the Orifice: Women in Gynecology Textbooks," 1974

Margaret was charged with obscenity for The Woman Rebel and brought to trial. Believing that she would be convicted and that going to jail at that time would do the cause of birth control no good, she fled to Europe for a year. While she was in Europe, Bill Sanger was arrested for distributing Family Limitation. His subsequent trial---"the law is on trial here, not I"--- and thirty-day sentence revealed that public opinion was shifting in favor of birth control. Margaret returned from Europe to find many active and vocal supporters. Opposition was even stronger,

however, and although The Woman Rebel charges were dropped, Margaret faced numerous attempts to silence her and nullify her work.

Undaunted, Margaret opened a birth control clinic in Brooklyn in 1916 to spread information she had gained in Holland, including the use of the pessary diaphragm. The clinic violated the contraception laws of New York, however, and Margaret and her sister both spent thirty days in the workhouse. Like other attempts to stop her, this one backfired--- the final outcome, following protests by an outraged public, was a relaxation of the laws. Margaret commented that attempting to silence her "makes millions of others talk about me, and the cause in which I live."

"Whatever your fight, don't be ladylike."

---'Mother' Jones (1830-1930)
American labor union organizer

Margaret was an independent woman, and her relationships with men showed the effects of her intense commitment to the birth control movement. Margaret and Bill Sanger found that their interests and activities diverged as time went on; they separated, and eventually divorced in 1920.

Margaret's second husband, oil millionnaire Noah Slee, spent a long time persuading her to marry him. She enjoyed her freedom; she doubted that she had either the time or the personal energy needed for a close companionship. Margaret finally agreed to marry Slee in 1922, but her work on birth control remained the first commitment of her life. He supported her work, at one time even smuggling literature about contraception in oil drums from Canada to the United States.

For Margaret, the 1920's and '30's were a period of unflagging, exhausting efforts to change the laws, to educate the public, and to get the active cooperation of medical people in both research and patient care. More and more people joined in this cause, some following Margaret's lead and others starting programs of their own.

Among the nationwide and worldwide organizations with which Margaret worked was the Birth Control Federation of America, which eventually became the Planned Parenthood Federation. By the time of World War II, when Margaret retired from active leadership, it was clear that the birth control movement could not be stopped---a major, permanent change was taking place in the lives of women and men around the world.

Margaret's supporters admired her to the point of hero worship, calling her "our beloved leader," "our guiding light," "a singing symbol." Her critics called her egotistical and power-hungry. Both the praise and the criticism are to be expected of a strong, charismatic leader singleheartedly devoted to a revolutionary cause. She was lucky to have been born in a time when it was possible for women to take active public leadership and to effect social change. The world is fortunate that the cause she chose was birth control.

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RACHEL CARSON
ecologist, writer

1907-1964; U.S.A.

Rachel Carson was a relatively obscure employee of the United States Fish and Wildlife Service in 1962 when the publication of her book, Silent Spring, suddenly launched her into the public eye. The book, a denunciation of the careless use of pesticides in the United States, mixed strong scientific fact with even stronger social convictions. Silent Spring effectively raised issues about the use of dangerous pesticides and started a storm of controversy.

Rachel was born into a farming family in 1907, the youngest of three children. From childhood she had access to---and developed a fascination for---the natural world around her. Her mother's strong influence fostered this fascination, as well as a strong literary interest. Rachel's mother, who remained her lifelong companion, encouraged Rachel not to marry.

Attending the Pennsylvania College for Women in Pittsburg, Rachel majored in zoology and then obtained a masters degree in the same field from Johns Hopkins University in Baltimore. She taught part time at Johns Hopkins and the Uni-

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versity of Maryland until she was hired in 1935 by the Bureau of Fisheries (later renamed the U.S. Fish and Wildlife Service). At this time she was one of the first two women hired by the Bureau for a nonclerical position.

Young, inexperienced, and at a disadvantage in a male-dominated environment, Rachel nonetheless slowly climbed the bureaucratic ladder. During her years with the Fish and Wildlife Service, she retained her interest in writing and made a significant contribution to government publications. Rachel published five books between 1941 and 1965: Under the Sea Wind, The Sea Around Us, The Edge of the Sea, Silent Spring, and The Sense of Wonder. Her books are considered to be an unusual and successful blend of science and literature.

It was a deep sense of concern and dedication that gave birth to Silent Spring. While working for the Fish and Wildlife Service, Rachel became aware of the dangers of DDT and viewed DDT insect control programs with personal alarm. DDT, the "miracle poison" developed in wartime, was very useful for emergency control of pests; yet its effects in postwar times had not been adequately evaluated.

Objections and rebuttals to Silent Spring were numerous, and Rachel incurred the wrath of many people. She did not accept the premise that technological development has to be accompanied by damage to the natural environment. She objected not only to the indiscriminate use of

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pesticides, but also to an irresponsible industrial society.

The furor surrounding Silent Spring prompted important governmental action under the direction of the President's Science Advisory Committee whose final report gave official endorsement to Rachel's assertions. Silent Spring opened the door to some legislative action favoring "safety first" and restricting the use of pesticides. Through this and her other books, Rachel influenced many people's thinking about what she called "our abuse of this planet."

"Another reviewer was offended because I made the statement that it is customary for pesticide manufacturers to support research on chemicals in the universities...I can scarcely believe the reviewer is unaware of it, because his own university is among those receiving such grants...the liaison between science and industry is a growing phenomenon, seen in other areas as well...When the scientific organization speaks, whose voice do we hear---that of science? or of the sustaining industry."

---Rachel Carson, speech to the Women's National Press Club, December 5, 1962

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CHIEN SHIUNG WU

physicist

born 1915; China, U.S.A.

Chien Shiung Wu, a nuclear physicist, is one of the most prominent women of modern science. Born in China, she is now a faculty member at Columbia University in New York.

Chien grew up in Liu Ho, a small town near Shanghai, where her father was the principal of a school. Her home was an intellectual one, and she and her two brothers were encouraged to read and learn. When she reached high school age, she was sent to Soochow to continue her education. There she excelled in science and mathematics courses and decided to become a physicist. From Soochow she went to Nanking to attend the government-supported National Central University where she received a bachelors degree in science in 1934.

Since graduate study in physics was limited in China at the time, Chien arranged to go to the United States to attend the University of California at Berkeley. She studied under Ernest Lawrence, director of the radiation laboratory, who was working on the developed of an atom-smashing cyclotron. While a graduate student, Chien worked as a teaching assistant and was elected to Phi Beta Kappa, an academic honor society. Also, she met Chi-Liu Yuan, another graduate student in physics, whom she married in 1942. They have one son, born in 1945.

Chien received her doctorate in nuclear physics in 1940. For her graduate research she studied x-radiation from beta decay (decay of radioactive substances when electrons are emited). She also studied radioactive noble (inert)

gases produced in uranium fission (atom splitting). The latter study was relevant to atom bomb research then in progress, so it was not made public until after World War II.

Chien continued as a research assistant in the radiation laboratory, doing pure research and then military research until 1942, when she went to teach at Smith College, a women's school in Massachusetts. A year later she was invited to Princeton University, a school which did not admit women students, to teach nuclear physics---an opportunity made possible, to some extent, by the wartime diversion of male physicists into military-related research projects.

"...we must start with the realization that, as much as women want to be good scientists and engineers, they want first and foremost to be womanly companions of men and to be mothers."

---Bruno Bettleheim (psychologist) in Mattfeld & Van Aken (eds.), Women in the Scientific Professions, 1965

Shortly after, Chien joined the science staff of the Division of War Research at Columbia University to work on the Manhattan Project---the code name for the atom bomb research work. She stayed there through the war, mainly developing instruments for the detection of radiation.

After the war, Chien became a research associate at Columbia University, where she continued her research on beta (electron) decay. She was promoted to Associate Professor of Physics at Columbia in 1952.

In 1956 Chien began working with two other Chinese-American physicists, Tsung Dao Lee of Columbia University, and Chen Ning Yang of the

Institute of Advanced Study at Princeton. Lee and Yang were questioning the principle of conservation of parity---which held that a process involving a nucleus is symmetric to the same process involving the mirror-image of the nucleus. Assisted by scientists from the Low Temperature Group of the National Bureau of Standards, Chien designed and conducted an experiment to test Lee and Yang's theory.

The experiment involved examining the electron emissions of radioactive cobalt nuclei aligned in a strong magnetic field at a very low temperature. The result was that electrons were emitted preferentially in a certain direction, but that the mirror image of this process did not occur. The experiment confirmed Lee and Yang's challenge to the principle of the conservation of parity.

Lee and Yang won the Nobel Prize in Physics in 1957 for their theoretical work. Chien Shiung Wu was promoted to full professor at Columbia; she became the seventh woman member of the United States National Academy of Sciences; and she received several honorary degrees ---including the first honorary doctorate given to a woman by Princeton University.

"Mind has no sex!"

---Hannah Crocker, 1818
American author

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JANE
GOODALL
animal behaviorist

born 1934; England

In the early 1960's a young Englishwoman of middle-class background began one of the most extensive studies ever attempted of chimpanzee behavior and its possible relation to human behavior.

Jane Goodall had been fascinated by live animals from the time she could crawl. When she was about a year old her mother gave her a toy chimpanzee. It became one of her most loved possessions, and she took it everywhere she went. Her love for animals deepened, and by the age of eight she had decided to go to Africa to live with wild animals when she grew up.

After leaving high school Jane took a secretarial course and then a job in a documentary film studio. Though she liked her job very much, her longing for Africa continued. Jane was fortunate enough to be invited to stay with a school friend on a farm in Kenya; she promptly quit her job to go to Africa.

In Nairobi Jane met the late Dr. Louis Leakey, a well-known anthropologist.* Leakey hired Jane as an assistant secretary at the Museum of Natural History where he was the curator. Sensing

*Jane Goodall was the first of several women researchers encouraged by Louis Leakey in their innovative studies of primates. Others are Shirley Strum (who studies baboons), Diane Fossey (who studies gorillas), and Biruté Galdikas-Brindamour (who studies orangutans). These women study the animals by living with them in their natural habitat.

her intense interest in animals, Leakey told Jane of the need for a study of the chimpanzees living on the shores of Lake Tanganyika. The area was cut off from population centers, and the study would require dedication and patience. Leakey suggested that if Jane would attempt the study, he would raise the funds needed to support the project.

"The troop was composed of seven adult males, 20 adult females, and 33 immature individuals...I questioned that the adult males, a small percentage of the troop, could be responsible so totally for its social life."

---Shirley Strum, "Life with the 'Pumphouse Gang': New Insights into Baboon Behavior," National Geographic, May 1975

Jane had no scientific qualifications and no university training, but Leakey minimized the need for academic experience. He thought that a person without academic biases but with a sympathetic understanding of animal behavior was often a better observer. Government officials agreed to the study but would not allow a young Englishwoman to live in the bush without a European companion. And so, in 1961, Jane's mother, Vanne Goodall, came to Africa to be with her daughter. Her mother stayed for five months; then Jane remained in the jungle for another year with two African assistants.

Jane spent fourteen months tracking down the frightened chimps, trying to make contact with them. For many of these months she could not get any closer than 500 feet before the chimps ran away. Eventually they began to accept her. She always looked the same and she never tried to follow them. The frightened chimps seemed to realize that she did not intend to harm them.

From Jane's observations during these difficult months emerged a fascinating portrait of the chimpanzee, humankind's closest primate relative. Her studies show that chimpanzees are intelligent, social animals able to communicate with one another through gestures, sounds, postures, and facial expressions. Their social life is complex, including a lengthy period of care for the young and many kinds of play. At one time thought to be vegetarian eaters, chimpanzees do capture and eat other kinds of animals. In addition, they can modify and use objects as tools.

Although Jane had never been to college, she was admitted to Cambridge University in England, thanks to the assistance of Leakey. There she worked for a doctorate in ethology, the study of primate behavior. She transformed her observational notes on chimpanzees into a thesis.

In 1964 Jane married Baron Hugo Van Lawick, a Dutch photographer whom Leakey had sent to Lake Tanganyika to assist Jane in her observations. They have a son, Hugo, nicknamed "Grub." In 1970 Jane and Hugo wrote In the Shadow of Man, an account of chimpanzee behavior and how Jane came to witness it firsthand.

Jane and her family still live near Lake Tanganyika. She continues her research at the Gombe Stream Research Center which she has helped develop since 1964. Today up to fifteen students from various universities study chimpanzee and baboon behavior there.

Jane Goodall's continuing study of chimpanzees is the most extensive of its kind, although it remains far from complete. Fourteen years after her first encounter with the chimpanzees she stated, "We've just about got to the stage of knowing which questions to ask."

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BRIEF SKETCHES OF OTHER WOMEN SCIENTISTS

ALESSANDRA GILIANI: (c. 1307-1326) An Italian who was a student and assistant of Mondino dei Liuzzi (a prominent 14th century anatomist). Allesandra was skilled in dissection and prepared demonstrations for Mondino's students. She devised a method for exhibiting the circulatory system by removing blood from the veins and arteries of a dead body and filling them with colored liquids which solidified.

SOPHIA BRAHE: (16th century) Danish astronomer, the sister of Tycho Brahe, a noted astronomer.

MARTINE DE BEAUSOLIEL: (17th century) French mineralogist and mining engineer.

MARIA CUNITZ: (17th century) An astronomer in Silesia (a part of central Europe, now Poland and Czechoslovakia).

MARGARET CAVENDISH: (1624-1674) An Englishwoman who wrote several popular works of science, some particularly for women, to inform people about current findings of Isaac Newton and other scientists in astronomy and microscopy.

MARIA KIRSH: (18th century) A German astronomer who assisted her husband, Gottfried Kirsh, with observations and calculations. Maria discovered a comet in 1702, but it was not named for her. After Gottfried's death in 1710, Maria and her daughters continued their astronomical work.

SIBELLA MASTERS: (died in 1720) An American inventor who developed a new method of cleaning and airing Indian corn. Sibella's was the first American invention to receive an English patent. However, the patent was in her husband's name.

MARIA GAETANA AGNESI: (1718-1799) An Italian mathematician who, after ten years of preparation, published a book called Institution Analytiche in 1748. She was offered a teaching position at the University of Bologna but decided to stop working on mathematics. Thereafter, she devoted herself to caring for poor, sick, and helpless people by setting up a hospital in her home.

ELIZA LUCAS PINCKNEY: (1723-1793) An American agronomist who perfected a method for cultivating and extracting indigo, a crop important to the economy of South Carolina during the eighteenth century.

CATHERINE GREENE:(18th century) An American who developed a plan for a machine to separate cotton from its seed---the cotton gin. Under her direction an employee, Eli Whitney, constructed the machine. Fearful of public scorn, she did not apply for the patent, and Whitney has been credited with the invention.

CAROLINE HERSCHEL: (1750-1847) An English astronomer who assisted her brother, William Herschel, as astronomer to the King. Caroline discovered eight comets and several nebulae and star clusters.

MARIA DALLE DONNE (1778-1842) An Italian physician and surgeon who held a chair of obstetrics and was in charge of a school for midwives.

ELIZABETH BLACKWELL: (1821-1910) The first woman to receive a medical degree in the United States. Elizabeth graduated from Geneva Medical College in upstate New York in 1849.

SOPHIA JEX-BLAKE: (1840-1912) Fought along with six other Englishwomen during the 1860's and '70's for the right to attend medical school at the University of Edinburgh in Scotland. When all efforts failed, Sophia helped to establish the London School of Medicine for Women, which opened in 1874. She attended that school and was licensed as a physician in 1877.

LUCY HOBBS TAYLOR (1833-1910) U.S.A. The world's first woman to attend and graduate from a dental school---from the Ohio Dental School, in 1866.

MARY KIES: (late 19th & early 20th centuries) The first American woman to receive a United States patent (in 1909). Mary developed a process of straw weaving with silk or thread.

MARGARET MALTBY: (1860-1944) A physicist and the first American woman to receive a doctorate from Göttingen University in Germany. Margaret did research on chemical solutions and radioactivity and taught at Barnard College in New York from 1900 to 1931.

ALICE HAMILTON: (1869-1970) An American physician who was a pioneer in the field of occupational health. She investigated work conditions, and in 1919 was one of the first faculty members of the department of industrial medicine at Harvard University in Massachusetts.

LISE MEITNER: (1878-1968) An Austrian physicist who did research on radioactive materials in Germany. Facing persecution as a Jew in Germany, Lise fled to Sweden in 1938. She coined the term

"fission" to describe how uranium atoms split when they are bombarded with neutrons.

AMALIE NOETHER: (1882-1935) A German mathematician and univerity professor who left Germany in 1933 after being fired by the Hitler government. "Emmy" emigrated to the United States where she taught at Bryn Mawr College in Philadelphia.

GERTY CORI: (1896-1957) An Austrian biochemist who came to the United States in 1922. With her husband, Carl Cori, Gerty studied enzymes of metabolism, discovered two new enzymes, and worked out the structure of the glycogen molecule. The Coris received the Nobel Prize in Physiology and Medicine in 1947.

IRÉNE JOLIET-CURIE (1897-1956) A French chemist who continued the research on radioactivity begun by her mother, Marie Curie. Iréne and her husband, Frédéric Joliet-Curie, received the Nobel Prize in Chemistry in 1935 for their discovery of artificially-created radioisotopes (radioactive forms of atoms produced by bombarding non-radioactive elements with alpha-particles in a cyclotron) and transmutation of atoms (changing one chemical element into another by bombardment with atomic particles).

MARIA GOEPPERT-MAYER: (1906-1972) The first woman to receive a Nobel Prize in theoretical physics (1963). Maria was born in Upper Silesia and educated in Göttingen, Germany. She came to the United States in 1930 with her husband, Joe Mayer, a chemist. After considerable difficulty getting a paying job, she taught at Sarah Lawrence College in New York, worked on atomic bomb research during World War II, and later did research at Columbia University, the University of Chicago, and at the University of California at La Jolla.

"Everybody thinks my head's full of nothing
Wants to put his special stuff in
Fill the space with candy wrapprers
Keep out sex and revolution, but there's no
Hole in my head.
Too bad."

--- from a song "No Hole in My Head" by Malvina Reynolds.

"Women also took up other jobs previously dominated by men such as engineering and architecture. Now women compose one-third of the advanced scientific researchers."

---Carma Hinton, "Women: The Long March Toward Equality," in New China, Spring 1975

"'His' and 'hers' should not divide the world, which is 'ours'."

---Mary Calderone
20th century American physician

"The task that seems of primary importance, both for women and men, is to convert science from what it is today, a social institution with a conservative function and defensive stand, into a liberating and healthy activity: science with a soul which would respect and love its objects of study and stress harmony and communication with the rest of the universe. When science fulfills its potential and becomes a tool for human liberation we will not have to worry about women 'fitting in,' because we will probably be at the forefront of that 'new' science."

--Rita Arditti, "Women in Science: 'Women Drink Water While Men Drink Wine,'" in Science for the People, March 1976

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